USER'S GUIDE

QED-4

Digital Defibrillator Analyzer

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WARNING

In addition to leakage tests, the following safety precautions must be followed to ensure the safety of the operator when using a defibrillator:

- Inspect the defibrillator daily. Examine the paddles, lead wires, and power cord for cracks and frays.
- If the defibrillator is line powered, be sure that it is plugged into a grounded receptacle.
- Do not touch the paddles on the defibrillator.
- Grip one paddle in each hand. Apply the paddles firmly (approximately 25 lbs of pressure) to the Model QED-4 plates. Keep the paddles firmly depressed on the plates to prevent arcing that can cause injury to the operator and can damage the Model QED-4 or the defibrillator.
- Do not touch the contact plates on the Model QED-4 when the defibrillator paddles are being pressed onto the plates.
- Do not use any electrical paste or pads when testing a defibrillator with the Model QED-4.

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INTRODUCTION

The Bio-Tek Model QED-4 Digital Defibrillator Analyzer accurately verifies the output characteristics of all defibrillators.

The Model QED-4 is battery operated and completely portable so that tests can be performed wherever needed.

The energy measured by the Model QED-4 is measured in Joules (Watt-seconds) on one of the two ranges: 0 — 199.9 or 0 — 1000 Joules. The output energy remains displayed on the Model QED-4 LCD until the operator presses the RESET button.

Accurate synchronization time in milliseconds (ms) is measured from a simulated 60 BPM "R" wave generated by the Model QED-4.

RS232C printer and performance waveform options are included on the Model QED-4R or can be added to a Model QED-4 later.

In addition, all output waveforms can be inspected during defibrillator discharge by using the waveform output jack on the Model QED-4 connected to an oscilloscope.

SPECIFICATIONS

Display	Digital (3 1/2-digit)
Ranges	0 — 199.9 Joules ±2% of reading ±1 Watt 0 — 1000 Joules ±2% of reading ±5 Watts
Voltage	0 — 5000 V
Pulse Width	0 — 50 ms
Input Impedance	50 Ohms ±1%
Accuracy	±2% of full scale for all waveforms, including trapezoidal waveforms to 50 ms duration and high-voltage pulses to 5000 V in amplitude

SPECIFICATIONS (Continued)

Oscilloscope Output	Red banana jack and LA snap lead jack with 1:1000 step down
ECG	60 BPM "R" wave ±1 BPM; 40 ms rise time and 20 ms fall time from RA, RL/LA, LL snap lead jacks Lead I (1 mV), Lead II (1 mV), Lead III (2 mV)
Synchronization Test	0 — 199.9 ms ±1% full scale or ±2 ms (Measured form start of "R" wave)
Power	Two 9 V alkaline batteries (1-year lifetime)
Weight	2.3 kg (5 lbs)
Dimensions	22.78 cm x 21.59 cm x 5.84 cm (8.97" x 8.5" x 2.29")
Reading Duration	Until reset by user
RS232C	(Optional)
Printer	(Optional)
Waveforms	(Optional)

ACCESSORIES

Description	**Quantity Supplied**	**Bio-Tek Part Number**
Carrying Case	1	3350012
QEDR Tags*	100	93006

* See Figure 1 for the QEDR Tag.

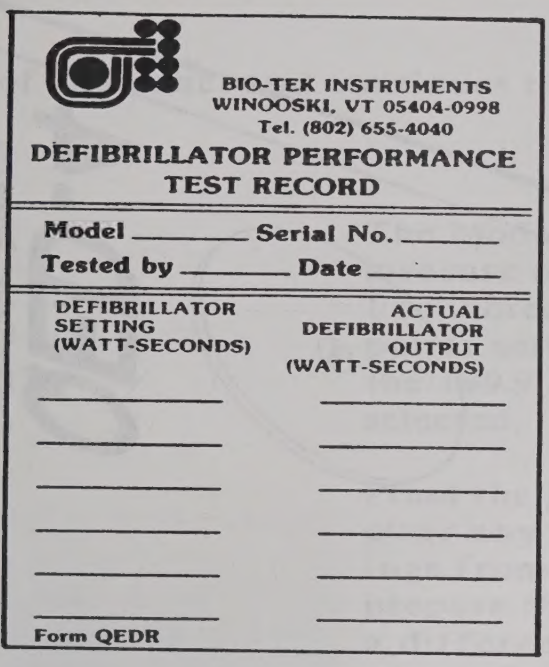


Figure 1. QEDR Tag for the Model QED-4

ACCESSORIES (Continued)

Description	Quantity Supplied	Bio-Tek Part Number
User's Guide	1	3351100
Warranty Card	1	--
RS232C/Printer Option	(Optional)	--

DESCRIPTION

The Model QED-4 is housed in a high-impact-resistant polystyrene case.

Front Panel

The front panel of the Model QED-4 is shown in Figure 2. The following description of the front panel starts at the upper

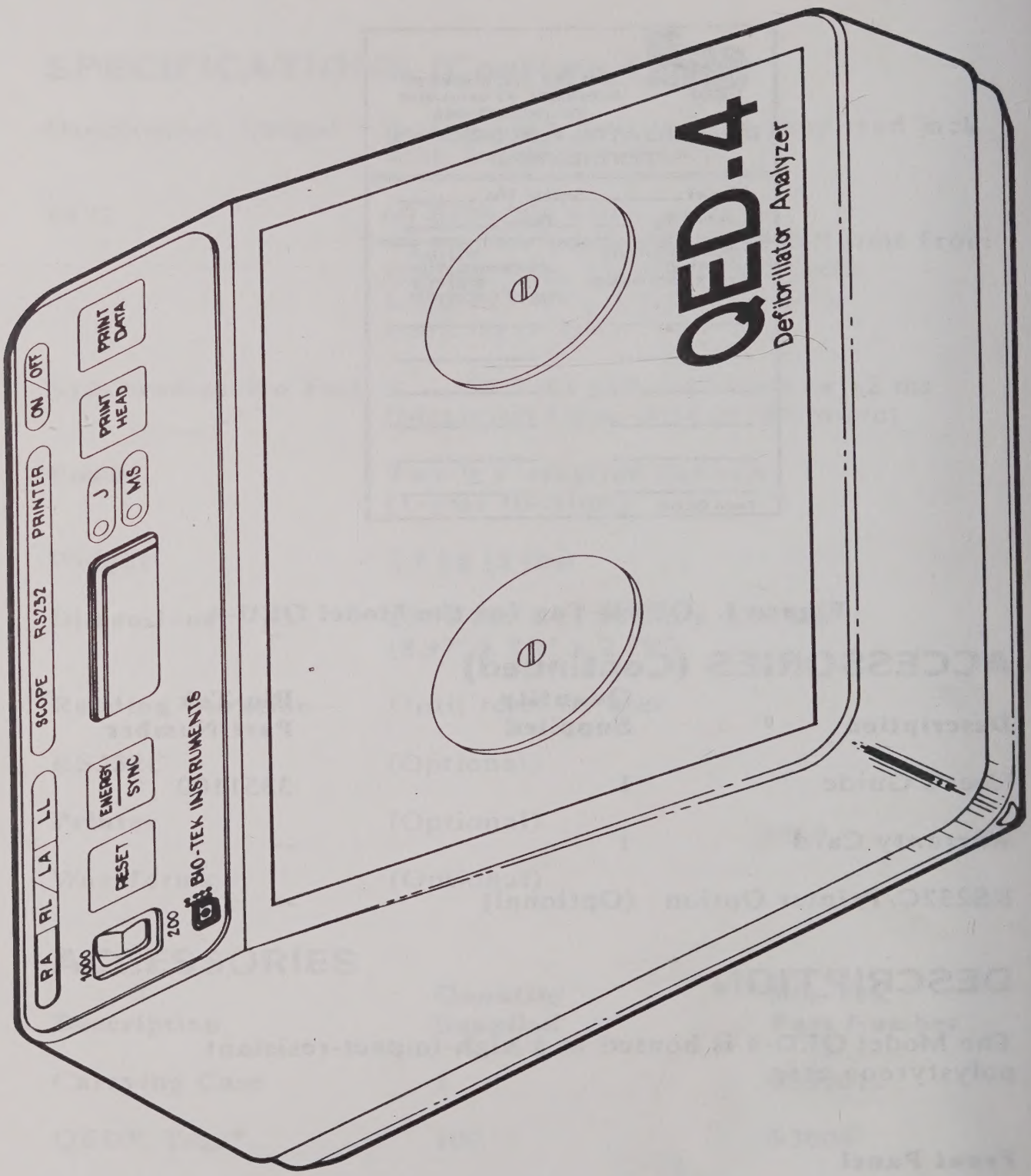


Figure 2. Model QED-4 Front Panel

lefthand corner of the panel and continues toward the righthand corner.

1000 J/199.9 J Range Selector

The Model QED-4 can measure output up to 1000 J. For increased accuracy at power settings below 199.9 J, the 199.9 J range should be selected.

RESET Button

Press the RESET button to clear any previous test readings from the display and to prepare the Model QED-4 for a different test.

ENERGY/SYNC Button

The ENERGY/SYNC button enables the operator to display either OUTPUT POWER or SYNCHRONIZATION test results that are performed simultaneously. If ENERGY is selected the J LED indicator to the right of the display will illuminate. If SYNC is selected the millisecond ms indicator will illuminate and blink at 60 BPM.

PRINT HEAD Button

This button is only operational if the PRINT HEAD option is purchased. When this button is pressed, the heading shown in Figure 3 is sent out the printer and RS232C ports. A new heading should be printed each time a different defibrillator is tested.

OPTIONAL PRINTER OUTPUT

Bio-Tek
Defibrillator Analyzer
Model QED-4

CONTROL #_____ SERIAL #____
MANF_____ MODEL _____
DATE_____ NEXT TEST__
OPERATOR

OUTPUT POWER:

DEFIB SETTING	DELIVERED POWER
_____	51 Joules
_____	96 Joules
_____	143 Joules
_____	182 Joules
_____	220 Joules
_____	267 Joules

SYNC TIME: 53 ms

Figure 3. Optional Printer Output

PRINT DATA Button — This button is operational only if the PRINT DATA option is purchased. Pressing this button sends whatever data are currently displayed to the printer (see Figure 3).

DISPLAY — The display is a 3 1/2-digit numeric LCD with a LOBAT indicator.

Defibrillator Electrodes — Two stainless steel electrodes enable the operator to contact the defibrillator paddles with the Model QED-4 contact plates while ensuring maximum safety.

Rear Panel

Figure 4 shows the rear panel of the Model QED-4.

ECG Output Jacks

A 60 BPM "R" wave is simulated by the Model QED-4 during SYNC tests; it is output via the RA, RL/LA, and LL snap jacks.

Banana Jack

The red banana jack and LA snap lead jack enable the operator to perform waveform analysis during output from the Model QED-4. The RL/LA snap lead jack provides a ground to the oscilloscope and the red banana jack provides an input for the probe.

RS232C, PRINTER PORT, AND ECG SIMULATION/ PERFORMANCE (Option)

These features are installed only in the Model QED-4R. (They can be added to the Model QED-4 at a later time.)

Figure 3 shows the printout available via the RS232C and parallel port.

The ECG SIMULATION/ PERFORMANCE test sequence is also part of this option. With the switch in the sequence mode, the waveforms in Figure 5 are output via the ECG jacks. In this mode, each waveform is automatically sequenced and then the cycle starts over.

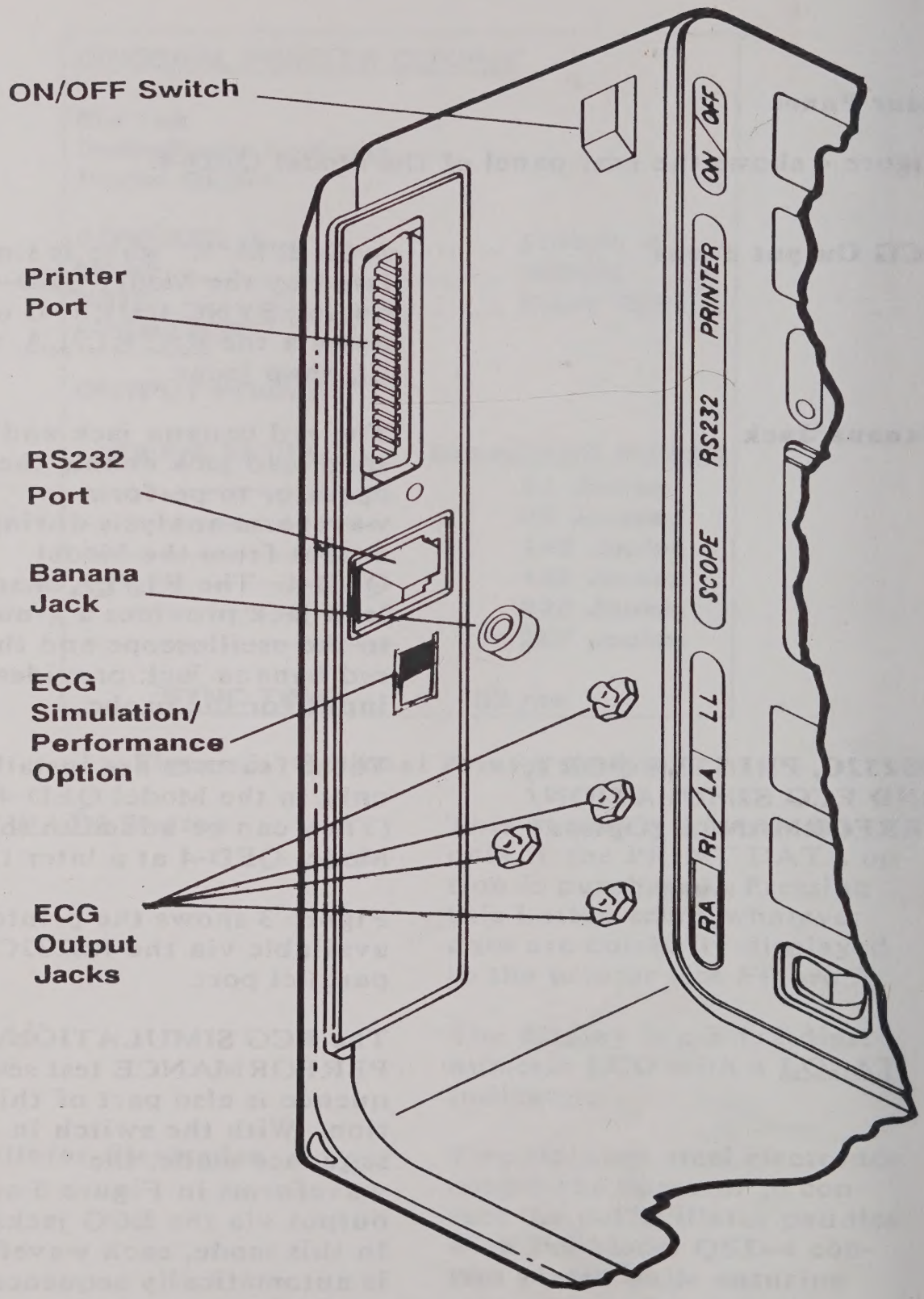


Figure 4. Model QED-4 Rear Panel

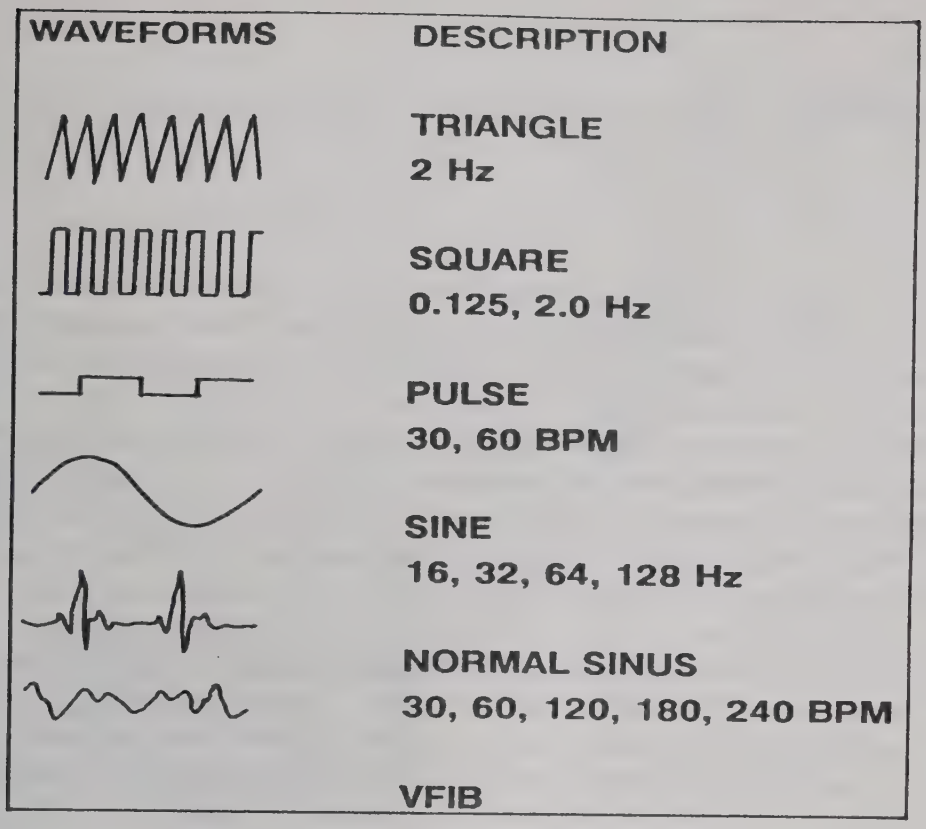


Figure 5. Output Waveforms

ON/OFF Switch

The ON/OFF switch on the Model QED-4 is used to empower the unit.

Bottom Panel

Battery Compartments

When the Model QED-4 is turned so that front panel facing down, the 2 battery compartments housing the 9 V alkaline batteries that empower the unit are exposed.

OPERATION

Energy

The Model QED-4 defibrillator analyzer measures the delivered energy from a defibrillator by simulating the human body's resistance to current flow; the analyzer then measures the flow of the energy through that resistance. The resistance of the human thorax under high voltage pulse conditions has been measured and found to be between 40 and 120 Ohms. The standard resistance chosen in the output of defibrillator energy is 50 Ohms. The Model QED-4 has a resistance of 50 Ohms, thus simulating the resistance of the human body.

The Model QED-4 computes the time integral of the power output from the defibrillator discharge. Energy is the product of current and voltage summed over the time during which the current and the voltage are applied. Mathematically, energy is expressed as:

$$W = \int_0^t E(t)\, I(t)\, dt$$

where:

W = energy
E(t) = voltage as a function of time
I(t) = current as a function of time.

Ohm's Law can be expressed by the following equation:

$$E(t) = I(t)\, R$$

where:

I(t) = current as a function of time
R = resistance in ohms.

The preceding 2 equations can be combined to give the following energy relationship:

$$W = {}_0\int^t R\, I^2\,(t_0)\, dt$$

where:

$$R = 50 \text{ ohms.}$$

The Model QED-4 performs the energy measurements by attenuating the input current; the Model QED-4 uses less than 1/1000 of the current supplied by the defibrillator. The Model QED-4 squares the input current using an integrated squaring circuit network and sums the current value (i.e., mathematically integrates) using a precision integrated circuit while at the same time multiplying by the constant "R." This provides the exact energy of the applied pulse.

Energy Test

1. Turn ON the defibrillator to be tested and select the desired energy output in accordance with the manufacturer's instructions.

   WARNING

   Observe all electrical safety precautions specified by the defibrillator manufacturer.

2. Turn ON the Model QED-4 by sliding the ON/OFF switch to the left.

3. On the Model QED-4, select the 0 — 199.9 J range for defibrillator outputs under 199.9 J or select the 0 — 1000 J range for defibrillator outputs over 200 J.

   NOTE: Select the 0 — 1000 J range if the output from the defibrillator is unknown.

4. Press the RESET button to clear the last reading and to *zero* the Model QED-4. A red light will blink at 60 BPM to indicate the energy measurement in joules (J). The light is located to the right of the LCD on the Model QED-4.

5. Simultaneously press the 2 defibrillator paddles onto the contact electrode plates on the front of the Model QED-4. Be sure to apply good pressure to the paddles on the plates.

6. Initiate a discharge from the defibrillator.

7. Observe the LCD on the Model QED-4 and record the defibrillator output settings and the actual readings displayed on the QEDR performance tag (see Figure 1).

   NOTE: The LCD will continue to display the reading until the RESET button on the Model QED-4 is pressed.

8. Perform Steps 3 through 7, preceding, at defibrillator outputs such as: 50, 100, 150, and 200 J.

Synchronization

When testing defibrillators in the synchronous mode, the Model QED-4 provides the defibrillator's ECG circuitry with a 60 BPM "R" wave. The "R" wave has a 40 ms rise/20 ms fall time. During normal operation the defibrillator recognizes and responds to this trigger by discharging within a certain amount of time. The Model QED-4 is capable of measuring up to 199.9 ms in delay time from the leading edge of the "R" wave. (100 ms or less is acceptable; this is equivalent to 60 ms from the *peak* of the "R" wave, as specified by some manufacturers.)

Sychronization Test

1. Attach 3 ECG leads from the defibrillator to the corresponding snap lead jacks on the Model QED-4. Use the RA, RL or LA for ground, and LL.

2. Turn ON the defibrillator to be tested and select the desired energy output and synchronous mode in accordance with the manufacturer's instructions.

3. Turn ON the Model QED-4 defibrillator analyzer.

   NOTE: The range selection switch has no effect on this test.

4. Press the RESET button to clear the previous reading and to *zero* the Model QED-4.

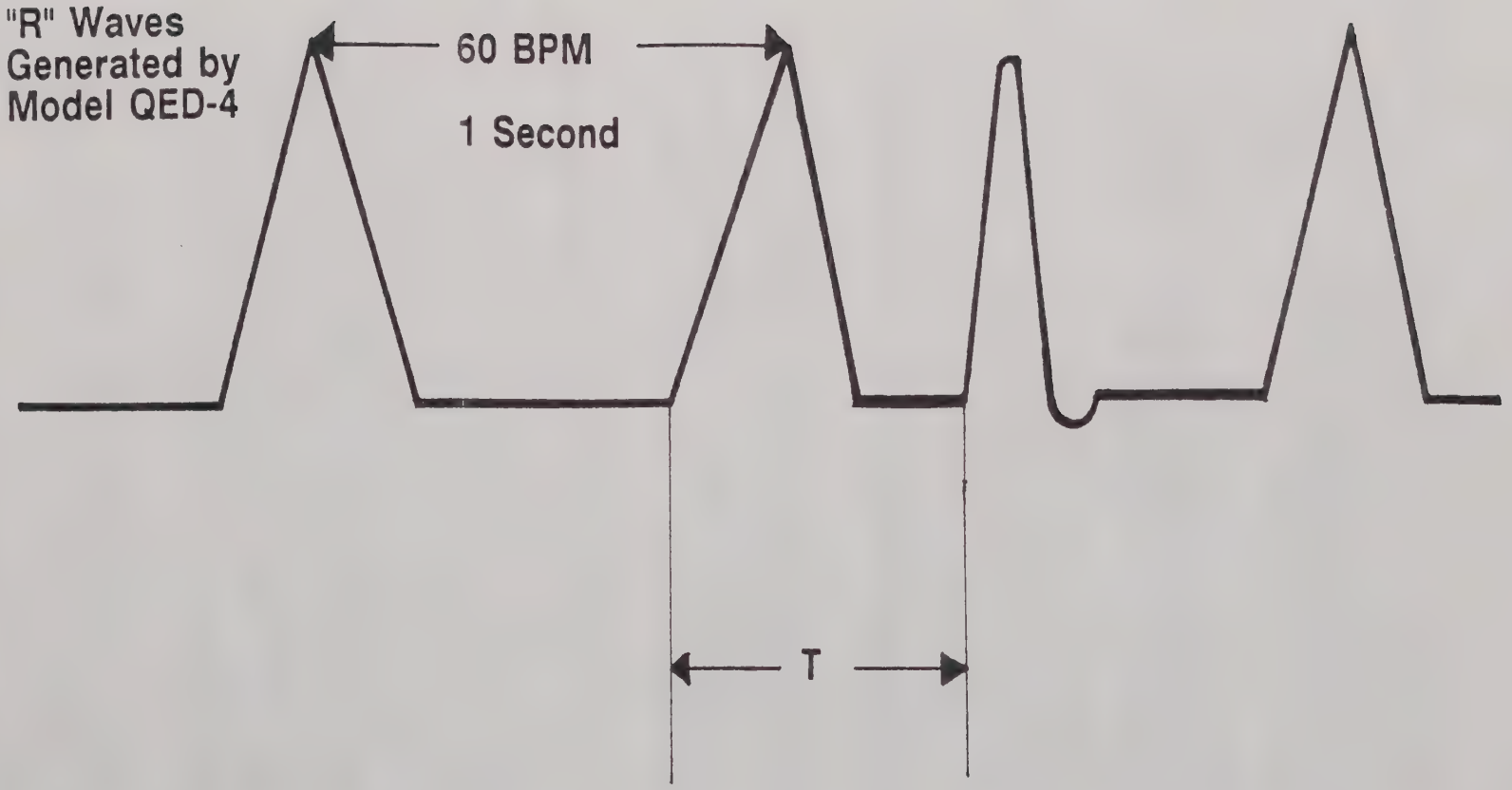
5. Press the ENERGY/SYNC button to select SYNC. A red LED will blink at 60 BPM indicating the sync time in milliseconds (ms); the LED is located to the right of the LCD on the Model QED-4.

6. Simultaneously press the 2 defibrillator paddles on the contact electrode plates on the front of the Model QED-4. Be sure to use good pressure on the paddles.

7. Initiate a discharge from the defibrillator.

8. After the trigger "R" wave is recognized by the defibrillator it should discharge and the delay time (in ms) will be displayed on the Model QED-4 LCD. The reading will continue to be displayed until the RESET button on the Model QED-4 is pressed. Record all values on the QEDR performance tag (see Figure 1). The synchronization diagram is shown in Figure 6.

9. If the energy reading is desired in joules, press the ENERGY/SYNC button to switch to energy readings in joules.



T = Displayed synchronization time measured from the start of the "R" wave to the defibrillator discharge up to 199.9 ms.

Figure 6. Synchronization Diagram

Waveform Inspection

The Model QED-4 provides an output for waveform inspection on an oscilloscope. The operator should perform the following procedure using a storage oscilloscope:

1. Connect the oscilloscope to the Model QED-4 using a banana plug from the red (the probe on the oscilloscope) to the red jack on the Model QED-4. Attach the black ground from the oscilloscope to the LA snap lead jack on the Model QED-4.

2. Set the oscilloscope trigger on EXTERNAL and connect a lead between the input of the oscilloscope and the external trigger input. (Alternately, internally trigger the waveform to be displayed.)

3. Set the time scale on the oscilloscope to 1 ms/division and then adjust to the desired expansion after observing the waveform output.

4. Set the gain on the oscilloscope to 0.2 V/division and then adjust to the desired level after observing the waveform.

5. Activate the storage control on the oscilloscope.

6. For most applications set the oscilloscope input-coupling control to the AC mode.

Testing

If the defibrillator under test is one that uses a discharge waveform with sizable DC components(i.e., trapezoidal or pulsitile discharge) improved output waveform fidelity can be obtained by placing the oscilloscope in the DC-coupling mode. The operator can then view the discharge waveform with a gain setting of 1.0 V/division or he or she can select a higher gain and use the oscilloscope vertical position control to help to center the output level of the Model QED-4.

1. Discharge the defibrillator into the Model QED-4. The waveform is 1/1000 of the input voltage through 50 Ohms. The actual magnitude of the discharge voltage can be obtained by using the following equation:

$$V_{discharge} = V_{scope}\,(1000)$$

where:

V_{scope} = oscilloscope input coupling.

2. Observe the waveform as it appears on the oscilloscope. Repeatedly discharge the defibrillator while adjusting the time and the gain to the optimal scale for the observance of the waveform.

3. If the waveform does not appear on the oscilloscope, reverse the placement of the defibrillator paddles on the Model QED-4 electrode contact plates. Repeat the discharge.

4. If the waveform still does not appear, readjust the trigger levels on the oscilloscope and repeat the preceding steps.

MAINTENANCE

Battery Replacement

When the BAT sign appears on the LCD of the Model QED-4, the battery power is low and the 2 batteries must be replaced. Turn the Model QED-4 over with the front panel facing down. Remove the external battery compartment cover on the back of the unit. Replace both used batteries with 9 V alkaline batteries.

SERVICE INFORMATION

The Model QED-4 should be returned to Bio-Tek if repairs are required. Contact our Service Hotline at the number provided following the Bio-Tek address to obtain a Return Authorization Number (RA #). Pack the unit carefully, insure for full retail value, and ship to:

Bio-Tek Instruments, Inc.
Highland Park, Box 998
Winooski, VT 05404-0998
Attn: Service Department
RA #

800-451-5172
TELEX 94-0136 BIO TEK SHVT
FAX 802-655-7941

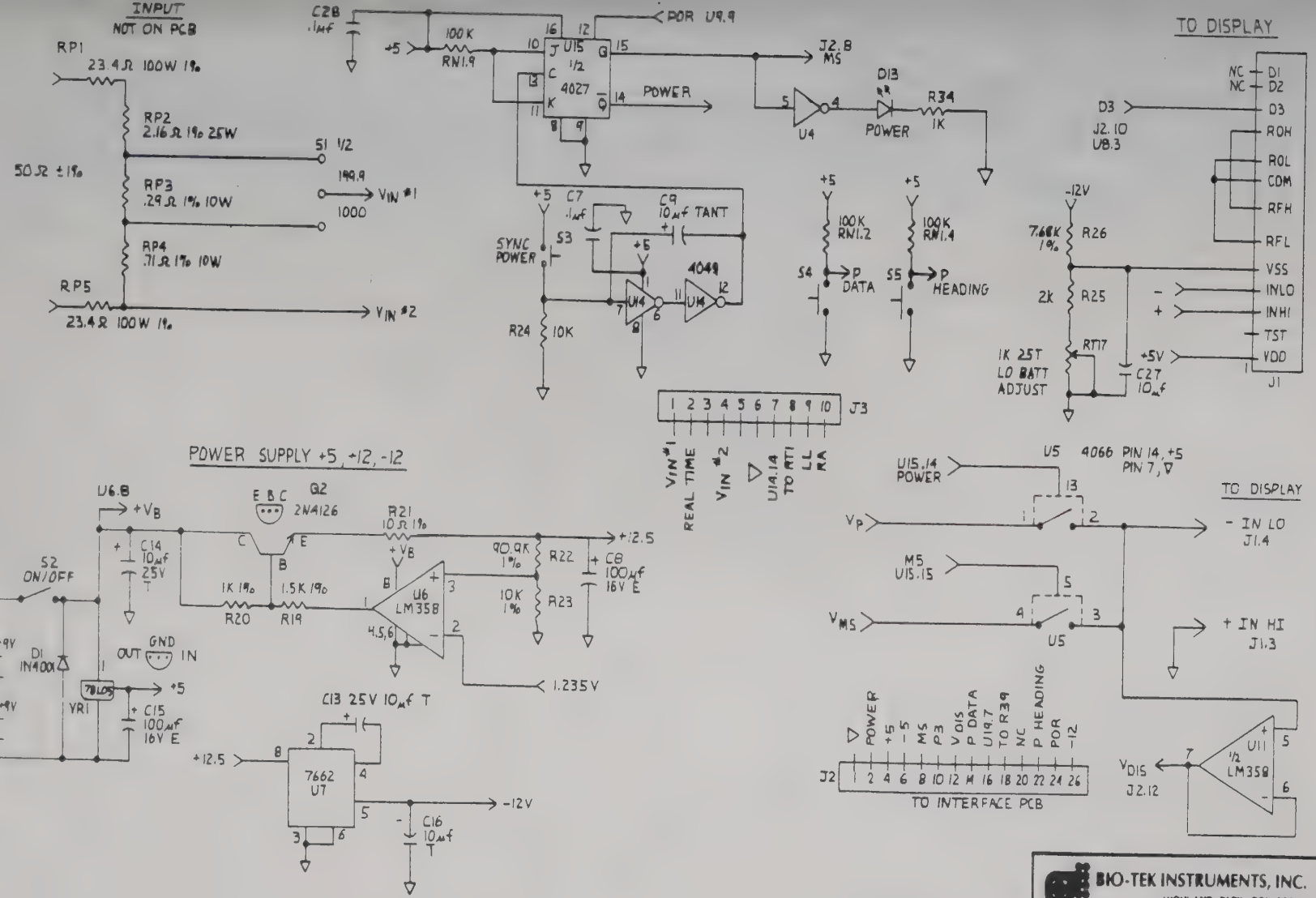
STORAGE

The Model QED-4 should be stored at 77^{o} F(25^{o} C) with a relative humidity of 50%. The Model QED-4 should be stored in its carrying case and the storage environment should be free of vibration.

SCHEMATICS

The following schematics should enable users who are familiar with electronic design to service and repair the Model QED-4. All questions pertaining to the Model QED-4 should be directed to the Bio-Tek Service Department.

NOTE: Bio-Tek continually upgrades its products when they are returned for service or repair; therefore, the schematic revision level can change. Please ensure that the schematics provided in this manual at the time of this printing match the revision level of your piece of equipment by contacting the Bio-Tek Service Department.



REV	DESCRIPTION	ECO	DATE	BY
A	RELEASE TO PRODUCTION			

REV	

APPROVALS	DATE
DRAWN SP	7/11/88
ENG	
MANAGER	

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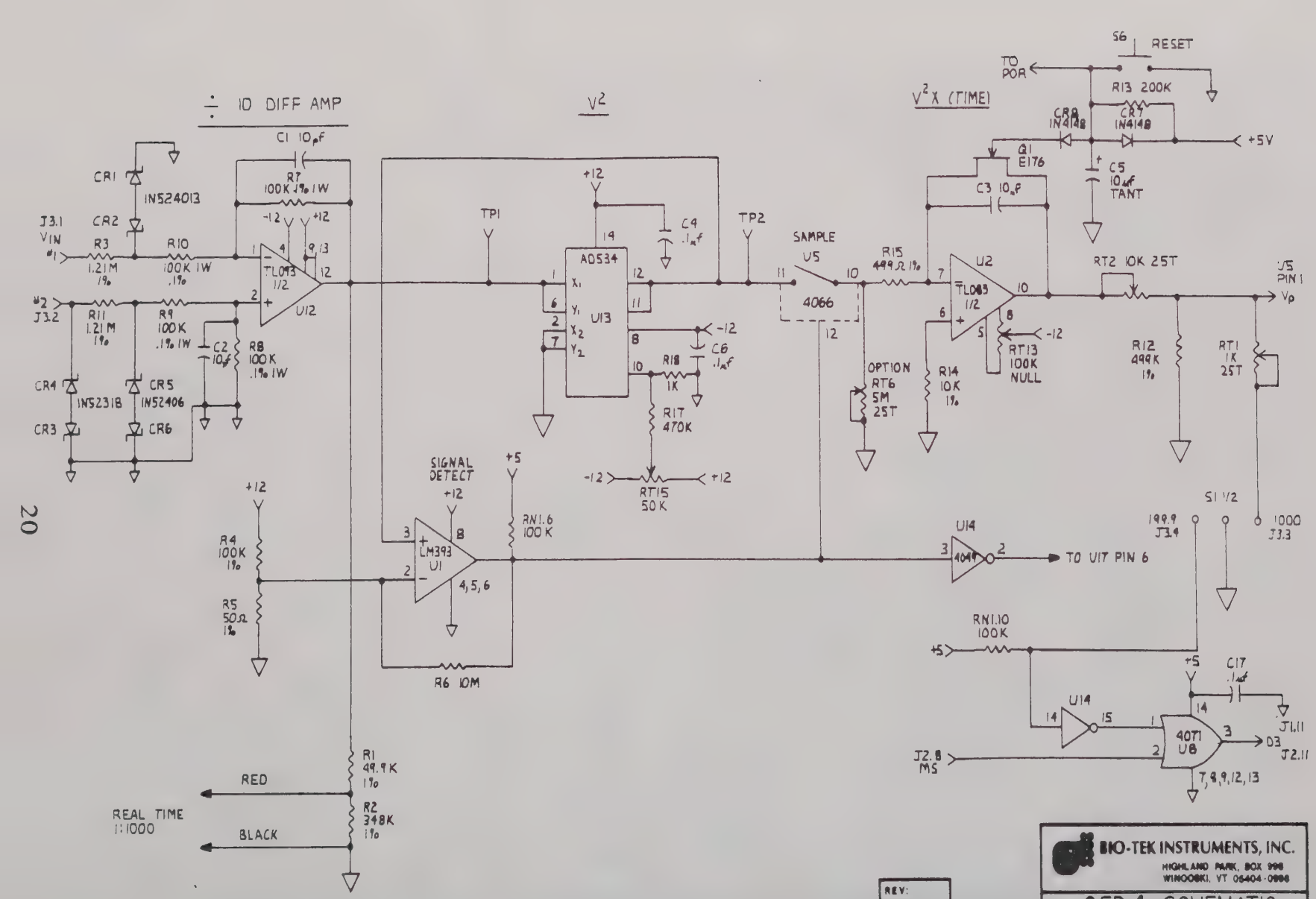
HIGHLAND PARK, BOX 998
WINOOSKI, VT 05404-0998

QED 4 SCHEMATIC
INPUT CIRCUIT, POWER SUPPLY

SCALE NA
SHEET 1 OF 3
DRAWING NO 3351400-SC



REV:	
APPROVALS	DATE
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ENG:	
MANAGER:	

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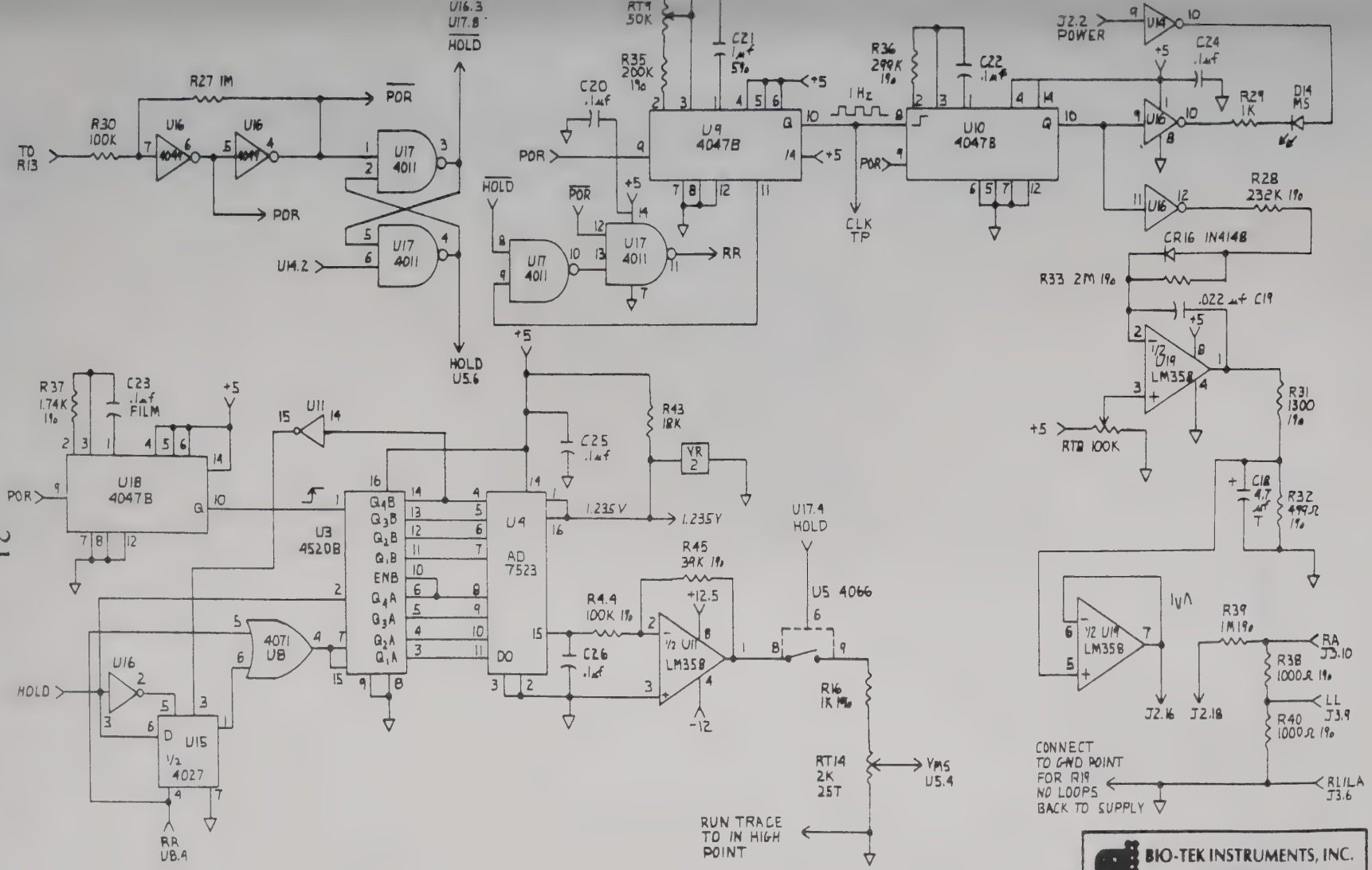
WINOOSKI, VT 05404-0998

QED 4 SCHEMATIC
SQUARING CIRCUIT

SCALE: NA
SHEET: 2 OF 3
DRAWING NO: 3351400-SC



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WINOOSKI, VT 05404-0998

REV.			
APPROVALS	DATE	QED 4 SCHEMATIC	
DRAWN	3/11/88	SYNC TEST	
ENG.		SCALE NA	DRAWING NO 3351400-SC
MANAGER		SHEET 3 OF 3	

NOTES

WARRANTY

Refer to the warranty card shipped with your unit for specific warranty information.

BIO-TEK INSTRUMENTS, INC.
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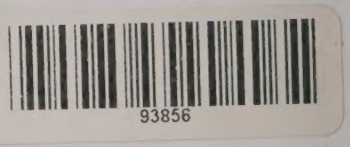
802-655-4040
800-451-5172
800-24-BIOTK (Service)
TELEX 94-0136 BIO TEK SHVT
FAX 802-655-7941



3/21/1989

Manual Part #3351100Rev. C